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ABSTRACT

Journal writing can be a valuable means of student assessment. If used in a pre-service education class, it can serve as a model of behavior that teacher educators would like to see students adapt for use in their own classrooms. This paper describes various formats that have been tried for the journals, the benefits of each, and the method that works best so far. Samples of student writing demonstrate the effectiveness of journals in convincing students of the advantages of integrating writing into the mathematics curriculum. It also presents a model for pre-service educators to integrate journals in their method courses. (ASK)

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Journal Writing: A Model for Mathematics Teacher Education

Cathy Liebars

Introduction.

The aspect of the mathematics education reform movement that most intrigued me when I started teaching college two years ago was the use of writing and in particular, journals, to evaluate students' learning. Such alternative methods of assessment are recommended by the National Council of Teachers of Mathematics in their document, Curriculum and Evaluation Standards for School Mathematics, in which "Mathematics as Communication" is one of the four themes that is stressed at every grade level. My investigation began with attending conferences and reading about the subject while experimenting with the use of journals in my classroom. I found that implementing journal-writing in my classes has not only benefited the student's understanding of mathematical concepts, but when used with pre-service teachers, it could convince them of the need to integrate writing in their future classrooms.

My teaching assignments each semester have included several sections of "Teaching Mathematics in the Elementary School." This is a course that is taken during the junior professional semester, in which the student spends half a day each week and two full weeks at the end in an elementary classroom. In this article, I will describe various formats I have tried for the journals, the benefits of each, and the method that I found to work best so far. Samples of my students' writing will demonstrate the effectiveness of the journals in convincing students of the advantages of integrating writing into the mathematics curriculum.

Open-ended Reflections

In the first semester that I required journal writing, the entries were to be open-ended reflections of what the student learned in class and reactions to the class activities for that week. Some students simply summarized what we did in class each week, while others demonstrated true insight into what could be gained from the activities presented. Students also used this opportunity to ask a question about things covered in class or to voice their concerns about the class, teaching, or mathematics in general. This provided me with excellent feedback.

I also found that by having students write about what they learned, I could discover misunderstandings they had and correct them. For example, one student wrote:

> "Throughout the class, division was not mentioned. This was because division is not pertinent in everyday life."

She incorrectly referred to the lesson on strategies for learning basic facts when I said that the Standards suggests decreased attention to isolated division facts since in real life a fact such as 42 , 6 appears with no greater frequency than a non-fact such as 43 , 6. Because she wrote this in her journal, I was able to immediately correct this misconception.

Another example of a misconception that I was able to correct after reading this journal entry was:

> "The relationship is that a parallelogram is a type of square. A trapezoid is a type of parallelogram. Thus a square is a type of trapezoid."

Once again it was a simple misunderstanding of something she remembered hearing in class, but with the details confused.

Since these students were in an elementary classroom for one day each week, I also asked them to write about their observations and mathematical experiences in the classroom. I collected these journals several times during the semester, checked them and gave feedback as needed. The students continued their journal writing during the last two weeks of the semester when they were in their classrooms full-time, and reflected on their own teaching.

In addition to the journals, I gave a written homework assignment in which they had to choose a profession (other than teaching) and write about how mathematics is used in that profession. This assignment helped them discover how important mathematics is in some professions that previously they thought never even used mathematics:

> "Before doing this assignment, I never really thought my father dealt with so much math (in his job). I also began to think about other professions that I never really thought involved mathematics. I came to the conclusion that math is very prevalent in almost every occupation today. I believe this would be a great activity for young children to take part in, especially when they begin to ask why they need to learn math."

Prompts for Journal Entries

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After the first semester of using journals to assess learning, the next semester I changed the format a bit and gave the students prompts to which they responded in their journals. I tried to use topics that could be used with elementary level students so they could see how to implement writing in their future classrooms, and at the same time assess their understanding of what was covered in class. Examples of the kinds of prompts I gave them were:

- What math means to me...
- Explain to someone how to model 23 x 5 using the base 10 blocks and how to record the solution.
- Write about an example of patterns in everyday life.
- Write a paragraph or a story using the metric terms centimeter, meter, kilometer, milliliter, and liter.
- Write a paragraph or poem about "What I would do if I were a..."(square, rectangle, trapezoid, triangle, circle, or even a 3-D figure.)

The first topic, "What math means to me," (which I continue to use with every class in which I use journal writing) gives me some insight into my students' mathematical backgrounds and their feelings about the subject. This also allows them to express any anxieties or negative feelings they might have about the class, which can be very therapeutic:

> "Math as a subject in school has always meant feelings of anxiety. It has always been the one subject that made me feel stupid and inadequate. Outside of school I use math successfully on a daily basis. I do not experience the same negative feelings about math when I am cooking or shopping or balancing my check-book."

I gave them several topics for which they had to explain a concept in their own words or explain how they solved a problem. Not only was I able to assess their understanding of the concepts, but the students realized how this activity aided in their learning process.

> "I was surprised by how much the journal writing has helped me to understand the math concepts. By forcing me to write down the math in words it helped to slow down my thought processes and realize how I mentally solve the problems."

> "The experience of journal writing has taught me that to truly understand something, you must be abie to explain it in words."

For the last entry, I asked them to reflect on the journal writing they did in class. I wanted to know if their opinions of integrating writing into the mathematics curriculum had changed, if they would consider using writing as a means of assessment in mathematics, and what they had learned from the experience. In addition to responding to these topics, they had to write reflections on their observations in the elementary classroom in which they had been placed and on their own teaching. This time I collected the journals every week and gave each entry a check plus, check, check minus, or 0, with a 0 only for an entry not submitted. Finally, I gave them an extra credit assignment which a few students tried. This was to incorporate writing into a mathematics lesson that they taught in the elementary classroom, reflect on what they learned from the experience, and submit the children's writing along with their reflections. One student who did this with a first grade class wrote:

> "From reading their responses, I learned approximately what percentage of the children were able to truly understand and answer my question (less than half of the class)...Some of the children who have displayed especially high intelligence gave answers showing a true understanding of my question. ."

She went on to write about what she would do differently in a similar teaching situation. Another student who tried the extra credit assignment with a fifth grade class wrote:

> "I learned that students' writing samples are great assessments for a teacher to know if all of her students understand the concepts being taught. As a result, this information could be used to improve the teacher's instruction because then she knows what material is necessary to review or reteach. I plan to continue using writing in the math curriculum when I become a teacher."

Journals and Portfolios

Overall, I found that giving prompts for the journal entries acquired a more positive response from the students than the open-ended reflections did in the first semester, so I decided to continue using this format for the third semester of teaching the methods course with one change. After I returned the journal entries with comments, the students placed them in a portfolio which was to be collected at the end of the semester. Then I asked them to turn in a summary with the portfolio which included their favorite homework assignment, their favorite journal topic, their best work and explanations as to why they chose the assignments to fill these categories. This really helped me to determine which topics were the most beneficial to the students and which ones they enjoyed the most. I discovered that students who like being creative most enjoy the assignments where they can use their creativity to write a story or a poem about mathematics. One such student wrote:

> "My favorite writing assignment was 'Welcome to Palindrome City, U.S.A.' This was a great way to assess my knowledge of palindromes without giving a formal test. The story had to be original and creative while at the same time conveying the concept of palindromes. I enjoy creative writing so this was a perfect way to get me interested in this mathematical idea. Students who are more linguistically inclined may prefer this type of assignment over a

routine math test."

As in the previous semester, I asked them to reflect on their journal writing and whether or not it changed their opinion of using writing to assess in a mathematics class. One student wrote:

> "To be perfectly honest, before this class I didn't see a place for writing in a mathematics curriculum. I didn't really understand how writing could be used to help children learn math. However, now that I have experienced the use of writing in mathematics myself, I feel I have a decent understanding of how I could use it in my own classroom someday. It is now my opinion that writing is essential in helping students learn mathematics in a more interesting and efficient method."

A Winning Combination

The format for the journals that best achieved my goals was a combination of the previously discussed methods. The entries had to contain reflections on class discussions and activities and responses to prompts given each week. Specifically, each entry had to contain:

1. A summary and discussion of what you learned in your own words.
2. Your personal accomplishments and reactions to activities.
3. Any open questions and/or analysis of your difficulties and concerns.

The same sort of prompts as I mentioned before were given, the first entry was to include "What Math Means to Me," and their last entry for the semester was a reflection on the journal-writing they had done. The grading was based on maintaining the frequency, volume, and completeness of the writing, not on mechanics or content, and I used a rubric which gave a score from 0-4 for each entry. I counted the journals as 25% of the final grade every semester.

A Model for Pre-service Educators

In comparing the different formats used for the journals in the methods course over the four semesters, this final method described above was the most successful and beneficial. The summary allowed me to assess their understanding of the course material and address any questions or concerns they were having. The topics given provided them with ideas of how to use writing in their future classrooms while also allowing them to be creative and to have fun! However, in every semester (after the first one), when I asked them to express their opinion of the journal writing after taking this course, with very few exceptions, their responses were overwhelmingly positive. This leads me to believe that in order to truly convince teacher education students of the benefits of any new method of assessment or teaching, the behavior should be modeled in their pre-service education classes. As evidence to this claim, I submit the following excerpts from my students' journals:

> "I will definitely use journal writing with my students, because for the past three months I have been playing the role of the student, and I have been witness to the benefits that this type of an activity possesses."

> "As a future teacher, I can now see the positive impact writing in mathematics can have for students. I will use this means of assessment in my classroom to help my students get the best out of all the lessons I teach them. Journal writing opened my eyes to a whole new teaching method."

> "This semester has helped me to see not only the value and importance of integrating writing into the mathematics curriculum, but also how to integrate writing into the mathematics curriculum...I will use writing in mathematics so that I can try to see into my students' heads, so that I can better help them to understand what we are doing, and so that they sit down and think through what they are doing."

Many students indicated that the experience had radically changed their opinions about using writing in the mathematics curriculum. It is not surprising that the idea was foreign to pre-service education students when they enrolled in this course. Some even had negative attitudes when first introduced to this method of assessment. For example:

> "My opinion regarding the integration of writing into the mathematics curriculum has changed dramatically since the beginning of this course. At first, I really did not see the point of the journal entries. However, as the semester progressed, I began to feel that not only were these entries a fresh and new approach to the mathematics curriculum, but a useful means of assessment. Through the journal, I was able to express how I felt about the lessons that were taught as well as the homework that was assigned. This allows students to express concerns on paper that they might not feel comfortable expressing aloud in class."

> "My opinion of integrating writing into mathematics has changed greatly since the beginning of the semester. At first I thought that the idea of keeping a journal in a math class was insane. I believed that writing and mathematics had nothing to do with one another. I now can see how valuable keeping the journal is. Writing about what I learned in class kept the material fresh in my mind...I have learned first-hand how it aids in the learning of new concepts."

> "Now that it is the end of the semester and I have had the opportunity to do several journals, my attitude has

changed dramatically. My writings have not only helped me to better understand the materials, but they have also given me more confidence."

"The journal writing seemed to be a little silly to me in the beginning. I felt that it was a waste of time. But I will tell you that there was more than one occasion when I knew an answer to a question on a quiz simply because it was something that I had written about the week before. I think it was that aspect that helped me to change my mind about the value of writing about mathematics."

"My view on integrating writing into the mathematics curriculum has changed in many ways through the journal writing that we have been required to do. In the beginning of the semester, I was open to this new movement, but dubious about its claims. After all, I had only read about the theoretical value of using writing in mathematics, yet I had never applied it until this course. I had thought it had potential to enhance both mathematics and English, but now I think it is vital. I will definitely use writing as a means of assessment in my mathematics classes becuase it has allowed me to more fully assess my own understanding of mathematical concepts."

For those students who already believed that writing in mathematics is beneficial, the experience in this course reinforced their belief and provided them with reasons to support it.

"I was honestly excited to keep a journal for this class because it forced me to remember what we learned in the previous class...But now that the semester has ended, I found the journal to be even more beneficial than I'd anticipated. I found myself thinking and wondering about mathematics more than ever before, and we only have class once a week!! Writing about math has forced me to understand it, with writing in my own words."

"I feel that writing in mathematics is very beneficial. Before this class, I thought it was, but I couldn't really explain why. But now, after having to do a journal entry every week, I see that it really helped me reflect on what I learned in class and reinforce it by writing it. Therefore, I think I will definitely use writing in my math clases because it will help my students remember things and also it will help me to know if my students understand things or not."

Some students who were not mathematically "gifted" found that writing better enabled them to comprehend mathematics. It gave them more confidence in their mathematical abilities and as a result, they enjoyed a subject that was previously thought to be unattainable.

"Writing about math has shown me that it is not one of nature's mysteries. Before I took this class I felt very uncomfortable about doing or discussing it. I always felt that it was the eleventh commandment of God, 'Thou shalt not try to comprehend math.' Now instead of being some unknown language I find myself expressing math and understanding and enjoying what it has to offer me. By integrating writing into the mathematics curriculum I can visualize and mentally connect the process or strategy involved with the end result. There is no 'math God' delivering answers to me. Through this experience I have come to the conclusion that this procedure could only be beneficial for the future students that I will be given to teach."

This is merely a sample of the evidence obtained to support my claim that the most effective way to convince pre-service education students that writing is an essential part of the mathematics curriculum is to model this means of assessment in their pre-service education courses.

Journals in Other Courses

This form of alternative assessment for mathematics can be extended to courses other than pre-service education. I have experienced success using journal-writing in a general education course for non-math majors. I used the same scoring rubric and requirements as I did with the methods students in the last semester, except in each entry, they had to include a solution to a homework problem. I counted the journals as 30% of their final grade. This gave non-math majors who had "math anxiety" a chance to improve their grades. Their last entry for the semester was a reflection on the journal- writing experience. I was surprised to discover that almost all of these students realized the benefits of writing in their weekly journals. One student wrote:

"Overall, I can report recording my thoughts and problems in a journal was extremely beneficial. After I organized my notes and work on paper, I found it easier to understand the lesson. Also, after I expressed my problems and my logic of thinking, getting my professor's feedback was helpful."

Summarizing what they learned in their own words forced them to review their notes and tie the week's lessons together. It allowed me to assess whether they really understood the material. Students who are not mathematically gifted enjoyed the chance to express themselves in writing as evidenced by these excerpts:

"I was able to write and explain myself, rather than just proving my skills in problem solving and numbers only. It is easier for me to express myself in writing, so I think the journal helped me, as well as others, greatly."

"I am naturally better at writing, and can understand things much better when I write about them..."

Another way I had to assess their understanding was through the solution of a homework problem required in each journal entry. They had to explain how they solved the problem, rather than just give an answer. They discovered that explaining their reasoning forced them to truly understand the concepts. What follows are some insights students shared:

> "I did like writing out homework problems because it gave me a chance to ask you specific questions about problems I was having and you would answer them for me. This is good because you can't always ask all of your questions in class."
>
> "By requiring us to explain one of our homework problems in our entry, we really had to know our stuff. It is one thing to plug a bunch of numbers into an equation, but in order to explain the problems in words, we really had to understand what we were doing, and why."
>
> "I must admit, when I first learned that we had to do a journal every week, I thought I would hate the class from the beginning. However, I found the journal not only to be helpful in the class, but also for my sanity...when I couldn't figure out a problem, working it out - actually writing out, word for word, every step of the problem - forced me to slow down and look at and analyze every step. It was then easier to see the trouble spots."

Some students found the journals to be an excellent source of communication between them and me. I did write comments and answer questions where appropriate and I think the students appreciated this and found it a way to get questions answered that perhaps they felt intimidated to ask in class. The following examples stress this point:

> "I was able to ask questions that I had once I got home and started my homework. I could write them down and you would have the answers for me. The journal really was a good idea overall. Not only did it answer my questions, but it gave me the chance to review my notes as well as let you know what I was having problems with."
>
> "The thing I liked most about the journals was the communication it provided between you and I. It takes off alot of pressure or tension when I don't understand something because I know I have a way to tell you."
>
> "I like the idea of the journals because it gives me opportunities to express my feelings and concerns with the teacher and I know that I can be understood. I feel the journals have helped me .. as far as understanding the material in that I get a better understanding of what I don't understand. It helps me to be clear with what I feel I know and what I feel I don't know. I have had a tough time with this class from the start and because of the journal writing I have had the chance to express my concerns with you and get some feedback."

Conclusion

Journal writing can be a valuable means of student assessment. If used in a pre-service education class, it can serve as a model of behavior that we as teacher educators would like to see our students adapt in their own classrooms. Writing forces a slow-down of one's thought processes, thereby allowing one to reflect and clarify their own thinking. It gives confidence to students who may not be mathematically inclined. It provides a means of communication between the teacher and student, and affords the opportunity to communicate mathematical ideas, which is one of the goals stressed in the NCTM's Standards. Journals can only enhance the learning of mathematics for a wide range of students, including liberal arts majors and pre-service educators.

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